Section 465
Issue No. 1
July 1956

Reprinted May 1978

REA-V1 TRANSPOSITION SYSTEM

1. GENERAL

1.1 This section is intended to provide REA borrowers, consulting engineers and other interested parties with technical information for use in the design and construction of REA-financed telephone systems. It discusses in particular a single circuit transposition system for windy areas. For purposes of identification, attention is called to the fact that preliminary memoranda referred to the REA-V1 System as the "extended interval system."

1.2 Open wire pole line having more than one circuit to which the single circuit lead may connect is to be transposed to an R1, R2 or other transposition system and is not covered in this section. The REA-V1 system may be employed on pole line jointly used with an electric distribution line or on a separate telephone line exposed to electric distribution lines.

1.3 In some areas where high winds are prevalent, experienc
that there is a high degree of probability of midspa
when tandem transposition brackets are employed even
of increased stringing tensions. The REA-V1 transpo
requires the use of 12" point type transposition bra
separation between wires of the pair. Since these a
than tandem brackets it is desirable to limit the nu
position points per mile. This transposition system
transpositions per mile than the R-1 or R-2 transpos
discussed in other sections of the manual, by coordi
line and telephone line discontinuities where the tw
constructed jointly or at roadway separation. Where
tion" is used in this section only distances between
power lines of 500 feet or less are considered. Whe
over 500 feet, transpositions should be placed appro
feet apart.

1.4 The REA-V1 transposition system is primarily designed for voice frequency applications. There is a region of serious absorption peaks between 80 and 160 KC so that carrier channels should not be applied in this frequency range.

1.5 Where the exposure results from joint use with electric lines, special attention must be paid to insure evenness of sag between both conductors of a pair.

2. DISCONTINUITIES

2.1 For the purposes of this section the following are considered to be power line discontinuities.

2.11 A change in the relative direction of electric and telephone lines:

(a) Where the two are on jointly-used poles, a pole where the two separate into two lines except for an occasional pole placed to avoid physical obstacles.

(b) Where an electric and telephone line are at roadway separation, a change in the distance between an electric and telephone line of the order of 2 to 1 or greater except for an occasional pole placed to avoid physical obstacles.

(c) Where there is a small angle (up to 30°) crossing of the telephone and electric line.

(d) Where there is an electric tap off the electric line at a small angle (up to 30°) and the electric tap length is 1/2 mile or greater.

2.12 Change in number of phases of electric line.

2.13 Location of large concentrated loads (50 KVA or over) including taps at any angle to the lines where the estimated load on the tap is 50 KVA or over.

2.14 End or beginning of parallel of telephone line with electric line.

2.15 Location of power factor correction capacitors.

2.2 The following are considered to be telephone line discontinuities:

2.21 Beginning of taps over 1/2 mile long.

2.22 End of the single circuit line or tap.

2.23 Last multi-circuit pole (the first pole where the line becomes a single circuit).

2.3 Staking of the line is normally carried out without consideration of the discontinuity points. However, discontinuity points are indicated on staking sheets and then pole top assemblies are determined according to the following design method.

3. DESIGN METHOD

3.1 The points at which transposition brackets are placed is determined by the following:

(1) The location of power or telephone line discontinuities.

(2) For those portions of the single circuit line between discontinuities, the maximum interval between transposition points is to be 1/2 mile.

3.2 Unlike the R1 and R2 transposition systems, locations of transposition brackets for the REA-V1 system may best be implemented after staking. Transposition units will probably have to be designated only after the entire circuit is staked. One or more transposition points are to be located between discontinuities so that, preferably, an even number of intervals are created. For the purposes of REA-V1 design an "interval" is either the distance between two transposition points where there is no discontinuity, or the distance from a discontinuity to the first transposition point in either direction. A "section" is the distance between two discontinuity points. Even with an even number of intervals in a section, it will not in general be practicable to locate transposition points so that the lengths of all intervals in a section are exactly the same. If an odd number of intervals is selected, there will be "unbalanced length" approximately the length of one of the intervals. This is undesirable because the greater the unbalanced length the greater the induced noise in the metallic circuit.

3.3 Calculation of Unbalanced Length.

Starting at the last multi-circuit pole (where a lead becomes a single circuit) going away from the central office, each interval is either considered as "+" or "-". Arbitrarily, the length from the last multi-circuit pole to the first transposition bracket on the single circuit lead is considered "+". The length from this bracket to the following transposition bracket is "-", and so on until a discontinuity is reached. Then all the pluses and all the minuses are added algebraically. The result is the unbalanced length.

3.4 The maximum unbalanced length is 1/2 mile. Where there is one or more discontinuities along a single circuit line, the square root of the sum of the squares of the unbalanced lengths of the various lengths between discontinuities should not exceed 1/2 mile or 2,640 feet.

4. EXAMPLE

Figure 1 represents a single circuit line, partly on joint use poles. The span lengths are shown, as is the location of all electric facilities in the immediate area. Locate all transposition points so that metallic noise induction will probably not be excessive.

Solution

1. Discontinuities are located first as follows:

Designation	Category per par.
"A"	2.11 (a) or 2.21
"B"	2.11 (a)
"C"	2.21
"D"	2.11 (a) or 2.21
"E" to "H"	2.22
"I"	2.11 (b)
"J"	2.23

2. Adding up the pole spans from the last multi-circuit pole to "A", the total length of the first section is seen to be 8,890 feet. Dividing this by 2,640 feet (1/2 mile) it is seen that the 8,890 feet must be divided into 3.4 or 4 intervals, by means of three point-type transpositions at approximate 1/4 points. The transposition point should be approximately at multiples of 8,890 ÷ 4 = 2,223' or 2,223', 4,446' and 6,669'. This would be the 6th, 13th and 20th poles going away from J.

Results are tabulated as follows.

"J" to "A"

Total length of section	8,890 feet
Divided by 2,640'	3.4 or 4
Number of transposition points	3
Approximate transposition point locations	2,223 feet, 4,446, 6,669 feet
Locate at	6th, 13th, and 20th poles from "J"

Results of above computations for this section and all other sections are shown in Table I.

The lengths of intervals for section "J" to "A" and all other sections is shown in Table II. The unbalanced length for each section (algebraic sum of these distances) is also shown in Table II.

Table I. Computation of single circuit transposition requirements for line shown in Fig. 1.

Section	Total section length (ft.)	Number of intervals in section	Number of transposition points	Approximate transposition point locations	Transposition poles
"J" to "A"	8,890	4	3	2,223' 4,446' & 6,669' from "J"	6th, 13th & 20th pole from "X"
"A" to "B"	5,200	2	1	2,600' from "A"	8th pole from "A"
"A" to "H"	6,190	4[1]	3	1,548', 3,096' & 4,644' from "A"	5th, 9th & 13th pole from "A"
"B" to "C"	3,425	2	1	1,713' from "B"	5th pole from "B"
"C" to "E"	5,110	2	1	2,555' from "C"	8th pole from "C"
"C" to "D"	3,320	2	1	1,660' from "C"	5th pole from "C"
"D" to "I"	1,680[2]	2[2]	1	840' from "D"	2nd pole from "D"
"D" to "F"	4,915	2	1	2,458' from "D"	8th pole from "D"
"I" to "G"	3,560	2	1	1,780' from "I"	5th pole from "I"

(footnotes to Table I)

1. Dividing 6,190' by 2,640' indicates 2.3 or 3 intervals. However, since this is an odd number it will lead to a large unbalanced length, and four intervals are therefore chosen.

2. Here there is an option to leave the total section untransposed and add the square of 1,680' of unbalanced length to the square root of the sum of the squares of all the unbalanced lengths; or to place a transposition at approximately the center of the 1,680'

Table II - Computation of unbalanced lengths resulting from transposition points derived in Table I.

Section	Pole	Length of interval	Unbalanced length (ft.)
	"J"		
		+2,025	
	6th		
		-2,405	
"J" to "A"	13th		-70
		+2,385	
	20th		
		-2,075	
	"A"		
	"A"		
		+2,730	
"A" to "B"	8th		+260
		-2,470	
	"B"		
	"A"		
		+1,695	
"A" to "H"	5th		
		-1,370	
	9th		-120
		+1,340	
	13th		
		-1,785	
	"H"		
	"B"		
		+1,650	
"B" to "C"	5th		-125
		-1,775	
	"C"		
	"C"		
		+2,690	
"C" to "E"	8th		+270
		-2,420	
	"E"		
	"C"		
		+1,680	
"C" to "D"	5th		+40
		-1,640	
	"D"		
	"D"		
		+705	
"D" to "I"	2nd		-270
		-975	
	"I"		
	"D"		
		+2,600	
"D" to "F"	8th		+285
		-2,315	
	"F"		
	"I"		
		+1,620	
"I" to "G"	5th		-320
		-1,940	
	"G"		

The unbalanced length between pole J and any end pole may be found by taking the square root of the sum of the squares of all the unbalanced lengths in tandem:

Between "J" and "H"

$$\sqrt{(-70)^2 + (120)^2} = 139 \text{ ft. ANS.}$$

Between "J" and "E"

$$\sqrt{(-70)^2 + (260)^2 + (-125)^2 + (270)^2} = 401 \text{ ft. ANS.}$$

Between "J" and "F"

$$\sqrt{(-70)^2 + (260)^2 + (-125)^2 + (40)^2 + (285)^2} = 413 \text{ ft. ANS.}$$

Between "J" and "G"

$$\sqrt{(-70)^2 + (260)^2 + (-125)^2 + (40)^2 + (-270)^2 + (-320)^2} = 515 \text{ ft. ANS.}$$

Thus it is seen that all unbalanced lengths are less than 2,640 feet with transposition points located as indicated in the last column of Table I, and metallic noise induction will probably not be excessive.

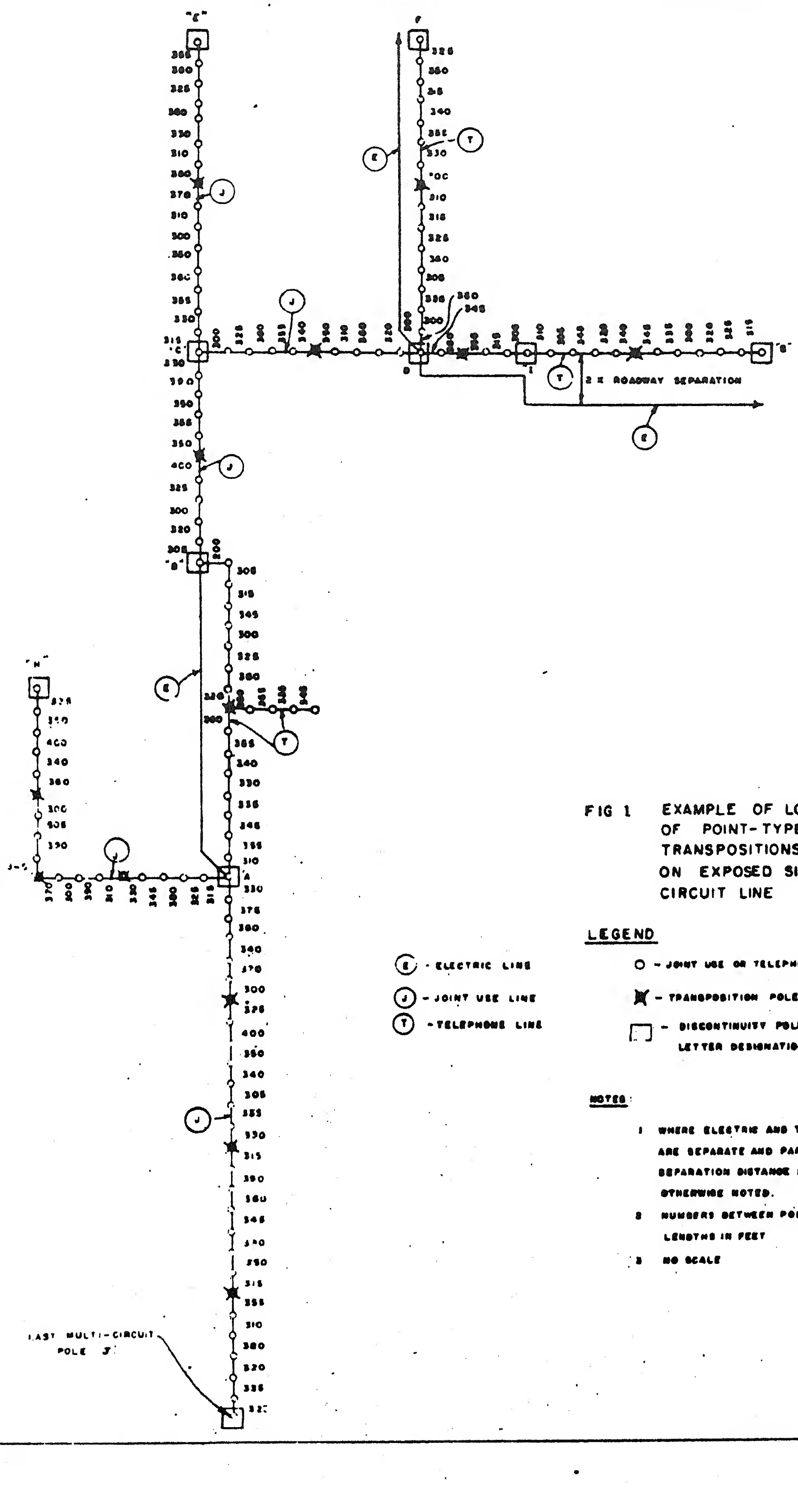

FIG 1 EXAMPLE OF LOCATION OF POINT-TYPE TRANSPOSITIONS ON EXPOSED SINGLE CIRCUIT LINE

LEGEND

- (E) - ELECTRIC LINE
- (J) - JOINT USE LINE
- (T) - TELEPHONE LINE
- O - JOINT USE OR TELEPHONE POLE
- ✱ - TRANSPOSITION POLE
- □ - DISCONTINUITY POLE (FOLLOWED BY LETTER DESIGNATION IN QUOTES)

NOTES:

1. WHERE ELECTRIC AND TELEPHONE LINES ARE SEPARATE AND PARALLEL EACH OTHER, SEPARATION DISTANCE IS ROADWAY, UNLESS OTHERWISE NOTED.
2. NUMBERS BETWEEN POLES ARE SPAN LENGTHS IN FEET.
3. NO SCALE.